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Observations of five little-known tubenoses from Melanesia in January 2017

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Summary.—We present observations of five little-known tubenoses made during a pelagic expedition from Vanuatu to New Ireland, Melanesia, in January 2017: Beck's Petrel *Pseudobulweria becki*, an all-dark *Pseudobulweria*, Magnificent Petrel *Pterodroma* (*brevipes*) *magnificens*, Vanuatu Petrel *P.* (*cervicalis*) *occulta* and Heinroth's Shearwater *Puffinus heinrothi*. Our observations provide some new insights into the following issues: Beck's Petrel—timing of breeding and search for the breeding grounds; all-dark *Pseudobulweria*—possible existence of an undescribed taxon in seas north-east of Papua New Guinea; Magnificent Petrel—sightings consistent with the argument for a distinct population; Vanuatu Petrel—variation in the underwing pattern and implications for its separation from White-necked Petrel *Pterodroma* (*c.*) *cervicalis*; and Heinroth's Shearwater—timing of breeding and search for the breeding grounds.

Background and Methods

Until fairly recently, the tubenoses of Melanesia were known mainly from the ill-fated Mencke Expedition (1900–01) and the rather more successful 1927–29 leg of the Whitney South Seas Expedition (see, e.g. Heinroth 1902, Murphy 1928, 1930). Little or nothing further was reported until the late 20th century. Recent studies have added important new findings, although large gaps in knowledge remain. We planned a pelagic expedition through Melanesian waters to study the five least-known tubenoses of the region: Beck's Petrel *Pseudobulweria becki* (rediscovered 2007; Shirihai 2008a), an unidentified all-dark *Pseudobulweria* (first seen 2003; Shirihai 2008a), Magnificent Petrel *Pterodroma* (*brevipes*) *magnificens* (described by Bretagnolle & Shirihai 2010), Vanuatu Petrel *P.* (*cervicalis*) *occulta* (resurrected 1983; Boles *et al*. 1985; rediscovered at sea in Vanuatu waters 2006–07; Shirihai & Bretagnolle 2010; breeding colony discovered in 2009 in northern Vanuatu; Totterman 2009), and Heinroth's Shearwater *Puffinus heinrothi* (rediscovered 1979; Hadden 1981; first documented at sea 2003; Shirihai 2004).

Our expedition dates were 6–31 January 2017, on board the 18 m-yacht *Sauvage* that specialises in visits to remote locations. A route was set from Port Vila, Vanuatu, to Silur Bay, New Ireland, Papua New Guinea, via the Banks Islands, Vanuatu, and Kolombangara Island, in the Solomon Islands, and returning to Kolombangara Island (Fig. 1). The distance travelled was *c.*3,000 km. The dates and route promised a reasonable chance of encountering our target taxa. The lunar cycle is important when visiting breeding colonies of petrels (e.g. Pinet *et al*. 2011, Rubolini *et al*. 2014) as greatest activity is usually around the new moon. However, a near four-week-long expedition, a few days short of a complete lunar cycle, made it impossible to visit all colonies and potential breeding areas around the new moon.

Potential challenges included the typhoon season (January–April) and the prevailing (opposing) north-west winds. However, eventually calm conditions throughout the expedition posed more problems; slowing our passage, becalming the petrels, and significantly reducing the effectiveness of chumming. Nevertheless, during daylight, while

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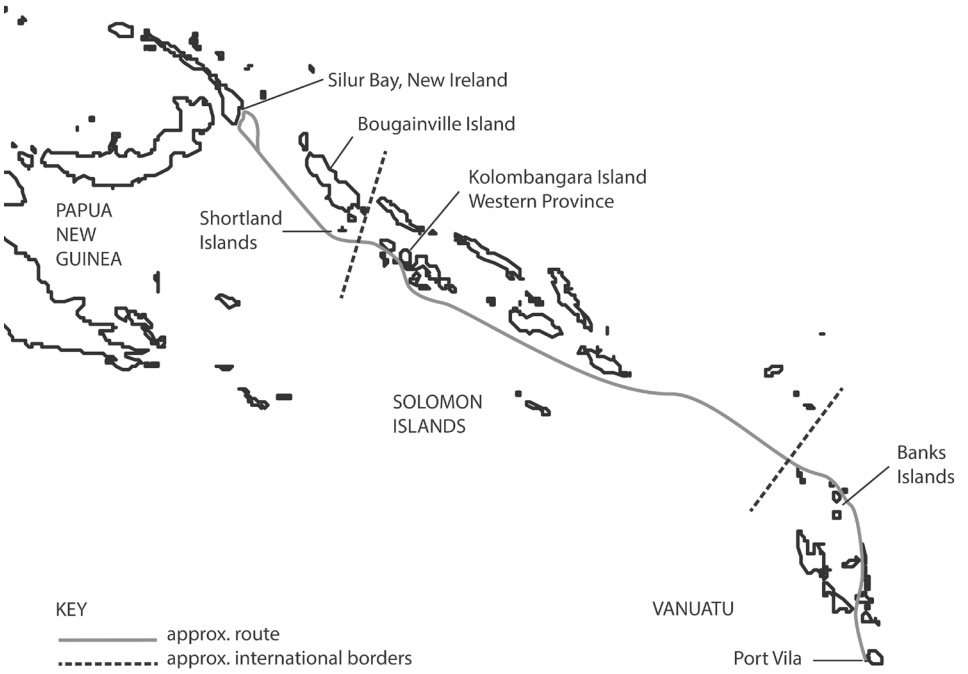

Figure 1. Map of the route followed by *Sauvage* January 2017. Departed Port Vila, Vanuatu, morning of 6 January, travelled to the Banks Islands, northern Vanuatu, arriving at Vanua Lava at noon on 8 January. Departed Vanua Lava at dusk on 10 January, then travelled to Western Province, Solomon Islands, arriving at Noro, Kohinggo Island, 16 January. Departed Noro late morning on 17 January passing through Blackett Strait, then to New Ireland, Papua New Guinea, arriving at Silur Bay early morning 20 January. Departed mid-morning 22 January, returned to Western Province, Solomon Islands, arriving at Vella Gulf at dusk 24 January. Repeatedly cruised Blackett Strait until disembarking at Gizo Island early afternoon 31 January (also visited Vella Gulf and Fergusson Passage).

motoring or sailing, we operated a fish-oil drip and, at key locations, towed onion bags full of semi-decomposed sardines. We attempted drifting and chumming several times, by establishing an oil slick and adding fish products, but this was largely unsuccessful due to an almost complete lack of wind. Wind disperses the smell of the chum and aids tubenose flight.

Results and Discussion

BECK'S PETREL *Pseudobulweria becki*

At first light on 20 January, at *c*.06.30 h, *Sauvage* was *c*.15 km south-east of Silur Bay in south-eastern New Ireland (Fig. 2). The first Beck's Petrel was seen *c*.10 km offshore as we approached the bay. The majority of sightings over the next few days were within 5 km of shore, mainly <2 km of shore, with some just 50 m from land. The birds rarely approached closer to the vessel than 100 m. We were unable to identify any fresh juveniles among the best-seen birds. A few were in active primary moult (see below) and the rest showed some degree of wear. Sightings on 20–22 January in the vicinity of Silur Bay were as follows. 20 January—24 birds to 08.30 h flying north, then eight to 15.30 h flying north / south, and two sat in the bay, with 12 to 16.00 h flying south during a squall, ten to 18.00 h flying south, and eight birds to dusk milling around the mouth of the bay (none within it). 21 January—18 to 08.30 h flying north, then 13 flying north / south to 15.30 h and two sat in the bay, but none

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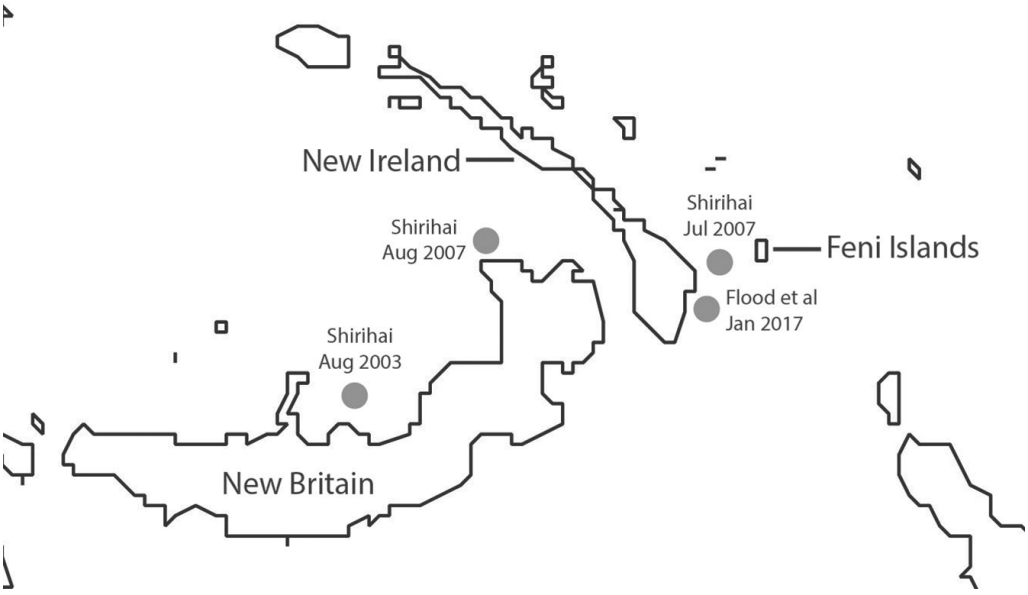

Figure 2. Map of the eastern Bismarck archipelago (including New Britain, New Ireland and Bougainville), showing localities mentioned in the text, and the locations of our and Shirihai's (2008a) sightings of an unidentified all-dark *Pseudobulweria*.

beyond 5 km in the direction of the Fini Islands to the east, 11.30 h to 15.30 h, then 18 and a Tahiti Petrel *P. rostrata* to dusk, with some Beck's Petrels milling at the mouth of Silur Bay. 22 January—none to 08.30 h, then three to 12.30 h while motoring south to Cape St. George, followed by 12 to dusk while sailing south-southeast from Cape St. George, most within the first 15 km, none beyond 40 km.

Wind and sea conditions were calm during the first two days, with just the occasional squall descending from the Hans Meyer Range (highest peak 2,379 m). On 22 January, the wind turned north-west force 4, giving blustery conditions and a choppy sea south of Cape St. George. Beck's Petrels favoured these windy conditions and few were seen in the lee of the island. Conditions returned to calm by early evening.

Very few Beck's / Tahiti Petrels were seen elsewhere. 10 January—one *P. rostrata* off Vanua Lava, Vanuatu. 19 January—one Beck's / Tahiti Petrel distantly *c*.90 km south-east of Cape St. George. 23 January—three *P. rostrata c*.100–200 km south-southeast of Cape St. George. Tahiti Petrels were seen well and fairly easily identified by size, structure and flight behaviour (see Shirihai 2008a).

The breeding grounds of Beck's Petrel are unknown and finding them is critical to its conservation. Concentrations off Cape St. George in July / August (Shirihai 2008a,b) and at Silur Bay in March / April (Bird 2012, Bird *et al*. 2014, Bird & Gaskin 2016) strongly suggest breeding in the nearby Hans Meyer Range. Our January sightings, mainly within or near Silur Bay, add weight to the supposition that Beck's Petrel breeds nearby.

The above sightings are consistent with a breeding season February / March–July / August. However, the closely related Tahiti Petrel is thought to breed year-round, with egg-laying peaks varying locally (Carboneras *et al*. 2017). Our sightings do not exclude this possibility for Beck's Petrel. Although our study found fewer birds in January compared to March / April (Bird 2012, Bird *et al*. 2014), some birds were loafing off Silur Bay in the evening, like active breeders. That said, other individuals were in active primary moult. Two examples photographed show outer five / six primaries old, moult ongoing among the

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inner five / four primaries. Procellariidae in active primary moult are unlikely to be nesting, as they usually start primary moult post-breeding. So, moulting birds could have been post-breeding adults, or immatures. Immature Procellariidae tend to disperse from the breeding grounds for several years, but dispersal patterns for Beck's Petrel are unknown.

ALL-DARK *PSEUDOBULWERIA*

On 21 January 2017, at *c*.15.10 h, we observed an all-dark *Pseudobulweria* resembling Fiji Petrel *P. macgillivrayi*, *c*.1 km offshore at the northern end of Silur Bay, New Ireland (04°25'S, 153°06'E; Fig. 2). It had been a calm day until a light squall descended from the Hans Mayer Range giving a 10–15 knot wind from the south-east. *Sauvage* was travelling south following the coastline *c*.1 km offshore. A fish-oil drip was running and we towed sardines from *c*.15.00 h. The bird was initially spotted in the wake by RLF. Flight was strong and purposeful as it progressed to within 150 m, before flying off in a more leisurely fashion to *c*.0.5 km from shore, then heading back and crossing the wake *c*.200 m away, before finally flying off north following the coast. The bird was in view for *c*.2 minutes and was also seen by ACW, KZ & M. Danzenbaker. Photographs were hurriedly taken as the bird crossed the wake, but the images are small and out of focus.

At first sight, head on, RLF thought that it was another Beck's Petrel. However, its flight action was more hurried and purposeful than Beck's Petrel, conveying the impression of a smaller bird. Overall dark plumage—eliminating Beck's Petrel, unless melanistic—was first seen when the bird peeled off toward the coast. Compared to Beck's Petrel, our bird was perhaps 10% smaller, with a more heavily built head and body, an apparently heavier bill, less pointed wings, and relatively short tail. The overall plumage was blackish, brownish black in the best light, with uniformly dark upperwings. A probable all-dark *Pseudobulweria* was briefly seen by RLF & ACW off Cape St. George, in southern New Ireland, at *c*.15.00 h on 22 January 2017, but it was further away than the first bird.

The main potential confusion genus for *Pseudobulweria* is *Bulweria*. The latter has long slim wings, elongated rear body, and all-dark plumage except for upperwing ulnar bars—typically strong in Bulwer's Petrel *B. bulwerii*, dull in Jouanin's Petrel *B. fallax* (Shirihai *et al*. 2009: 140). There are reports of Bulwer's Petrel in the region, including one during our expedition, but the main potential confusion species is Jouanin's Petrel, given its size and typically dull upperwing ulnar bars. Shirihai *et al*. (2009: 141) noted that experienced observers will differentiate Fiji Petrel (hence a Fiji-like Petrel) from *Bulweria* by their characteristic flight. Our experience includes >200 Jouanin's Petrels off Oman (Flood 2016) and at least three different populations of Bulwer's Petrel (e.g. Flood & Fisher 2011). Two of us have experience in distinguishing all-dark Mascarene Petrel *P. aterrima* from Bulwer's Petrel (Flood *et al*. 2015).

The flight actions of our bird were more like a *Pterodroma* than a *Bulweria*. Flight was consistently strong and steady, with fairly stiff wingbeats, and the bird climbed to >8 m on several occasions. *Bulweria* has especially low wing loading, consequently an effortless buoyant flight, gliding for long periods, meandering or with erratic changes of direction, has flexible wingbeats, and flies low over the water in relatively calm conditions such as on 21 January 2017. Given the same conditions, the flight action of Jouanin's Petrel is slower than the smaller Bulwer's Petrel, with floppier wingbeats (Flood 2016).

Shirihai (2008a: 13) reported three sightings of all-dark *Pseudobulweria* that resembled Fiji Petrel in the Bismarck Archipelago (Fig. 2). The main characteristics of our bird on 21 January 2017 match his birds. We are aware of two other sightings of all-dark *Pseudobulweria* in the same general area: 12 April 2007, at 01º42'S, 153º56'E, and 19 April 2008, at 05º38'S, 153º56'E (S. N. G. Howell, P. Fraser & I. Sinclair *in litt*. 2017).

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It seems unlikely that the relatively tight cluster of all-dark *Pseudobulweria* sightings around New Britain and New Ireland simply reflects greater effort. Since 2006, several commercial and privately funded expeditions have sailed from New Caledonia / Fiji northward, without encountering all-dark *Pseudobulweria* in Vanuatu or the Solomons. In addition, evidence to date indicates that Fiji Petrel is very rare, with only eight observed during an intensive search off Gau, Fiji, where it probably breeds (Shirihai *et al*. 2009). Thus, if the birds are Fiji Petrels, then either the region is a key foraging zone for the Gau population (breeding *c*.3,000 km away), or it holds a previously undiscovered population.

Alternatively, the Papua New Guinea all-dark *Pseudobulweria* may be an undescribed taxon. Indeed, following his work off Gau, Shirihai *et al*. (2009: 145) concluded that the Bismarck birds had a different shape and flight behaviour compared to Fiji Petrel.

Our sighting off Silur Bay, as with Beck's Petrel (Bird *et al*. 2014), suggests that breeding might occur in the Hans Meyer Range. The possibility that all-dark *Pseudobulweria* breed in the region should be kept in mind when searching for the breeding grounds of Beck's Petrel.

MAGNIFICENT PETREL *Pterodroma* (*brevipes*) *magnificens*

All except one of our sightings of Magnificent Petrel were south of Vanua Lava, Banks Islands, northern Vanuatu, where it apparently breeds (Bretagnolle & Shirihai 2010, Tennyson *et al*. 2012). 7 January—42 birds over the deep waters enclosed to the west by the islands of Malekula and Espiritu Santo, and to the east by Pentecost and Maewo. 8 January—four birds during the morning approach to Vanua Lava. 9 January—one close to Vanua Lava late evening. Photographs show birds in fresh plumage. No other *Cookilaria* were seen during the expedition.

Collared Petrels were categorised into four plumage-types by Watling (1986), illustrated with photographs in Bretagnolle & Shirihai (2010: 294). Using the latter, Magnificent Petrels are mainly 'dark grey' (darkest category), with some paler below and categorised 'smoky' (Bretagnolle & Shirihai 2010: 287). Most of our birds were 'dark grey' with a minority 'smoky.' None were of the paler types 'grey peppering' or 'pure white'.

Bretagnolle & Shirihai (2010: 293) reported 180 Magnificent Petrels during their expedition to the Banks Islands in December 2009. They were mainly 'dark grey' (*c*.90%) with the rest 'smoky' (*c*.10%). On 24 April 2014, an expedition cruiser crossed the same deep waters between Malekula and Espiritu Santo on the one hand, and Pentecost and Maewo on the other. A squall pushed a group of *c*.20 Magnificent Petrels across the ship's bow. Again, most were 'dark grey' with the rest 'smoky' (C. Collins *in litt*. 2017). The palest 'smoky' individual (Fig. 3) stood out from the rest of the group. Concentrations of entirely dark-morph birds ('dark grey' and 'smoky') in December 2009 (180), in April 2014 (*c*.20) and in January 2017 (46) point to a distinct population.

Bretagnolle & Shirihai (2010) described Magnificent Petrel as a race of Collared Petrel *P. brevipes*, based on its smaller size, monomorphic plumage and timing of breeding. They stated that the vast majority of their December 2009 birds were juveniles and therefore concluded that Magnificent Petrel must breed in the austral summer, or earlier (criteria for ageing not given). Elsewhere, Collared Petrel typically breeds in the austral autumn / winter (mainly March–August, and could look quite fresh in December), is not known to breed year-round, and largely disperses from the breeding colonies (Watling 1986).

However, taxon status for Magnificent Petrel was contested by Tennyson *et al*. (2012). They questioned the presence of a larger and paler bird, collected concurrently with the type series of *P. b. magnificens*, which Bretagnolle & Shirihai (2010) considered to be a visiting *P. brevipes*. Its inclusion makes the Vanua Lava population more like other populations of Collared Petrel; it increases the biometric mean values and points to polymorphism.

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Figure 3. Presumed Magnificent Petrel *Pterodroma* (*brevipes*) *magnificens*, between Malekula and Espiritu Santo Islands, and Pentecost and Maewo Islands, Vanuatu, 24 April 2014 (Kirk Zufelt). Rather distant when photographed, this is the palest bird of 60 seen in these waters in April 2014 and January 2017. This individual is a shade lighter than the palest Magnificent Petrel in Bretagnolle & Shirihai (2010: 294, Fig. 8). Bretagnolle & Shirihai stated that the bird in their Fig. 8 was borderline between 'dark grey' and 'smoky', thus we label this bird 'smoky'. Bretagnolle & Shirihai (2010: 291, Table 2) scored Magnificent Petrels at sea off Banks Islands, Vanuatu, and found that 10.53% were smoky (the rest extreme / dark grey); they scored the type series from the same waters and found 20% were smoky (the rest extreme / dark grey).

Tennyson *et al*. (2012) visited Vanua Lava in March 2011. At night they captured two birds with similar biometrics, one 'dark grey', the other 'paler' (flashlight photographs in Tennyson *et al*. 2012: 43). They presented this as evidence that pale birds can be the same size as Magnificent Petrel. Despite the particularly strong flashlight on the paler bird, it shows a grey wash to the underparts, perhaps sufficient to qualify as 'smoky'.

Tennyson *et al*. (2012) also reported that paler birds seen in the spotlight encompassed the three paler morphs of Collared Petrel. Accordingly, they concluded that the *Cookilaria* breeding on Vanua Lava is Collared Petrel, with a higher proportion of dark-morph birds than other colonies, and that the birds observed by Bretagnolle & Shirihai in December 2009 were fresh adults ready to breed in the austral autumn / winter, as at other colonies of *P. brevipes*. In our experience, interpreting plumage shades in a spotlight is subjective and potentially unreliable. We prefer to restrict our comments to specimens and well-photographed birds. However, sightings at the colony on Vanua Lava in March (autumn) is within the main breeding period of Collared Petrels elsewhere.

During our visit to Vanua Lava on 8–10 January, just one bird was seen near the breeding island, in the evening, and there was no other sign of birds returning to the colony. We spent three afternoons and evenings north-east of Vanua Lava at the December 2009 'hotspot' for Magnificent Petrels (H. Shirihai *in litt*. 2017) and Vanuatu Petrels *P.* (*c.*) *occulta* (Bretagnolle & Shirihai 2010: 139).

One explanation is that conditions for returning to the colony were less favourable during our visit, given calm weather and an 81–85% waxing moon (although a fair number of Vanuatu Petrels were seen, see below). Bretagnolle & Shirihai experienced more favourable conditions, with a new moon becoming a *c*.50% waxing moon. However, our visit was *c*.1 month later than that by Bretagnolle & Shirihai. Thus, if their birds were juveniles, then our visit may have followed post-breeding dispersal.

VANUATU PETREL *Pterodroma* (*cervicalis*) *occulta*

Observed at sea from *c*.50 km south to *c*.150 km north of Vanua Lava, Banks Islands, northern Vanuatu, where breeding has recently been documented (Totterman 2009). Birds were sparsely distributed at sea. Nevertheless, our sightings give some indication of foraging range in the breeding season. The rest of our sightings were off Vanua Lava.

We arrived at Vanua Lava at noon on 8 January and departed at dusk on 10 January. Late afternoon and evening were spent north-east of Vanua Lava at a 'hotspot' for returning Vanuatu Petrels (Shirihai & Bretagnolle 2010; Fig. 4). At night we drifted off north-east Vanua Lava. Morning and midday were mainly spent searching for feeding frenzies of

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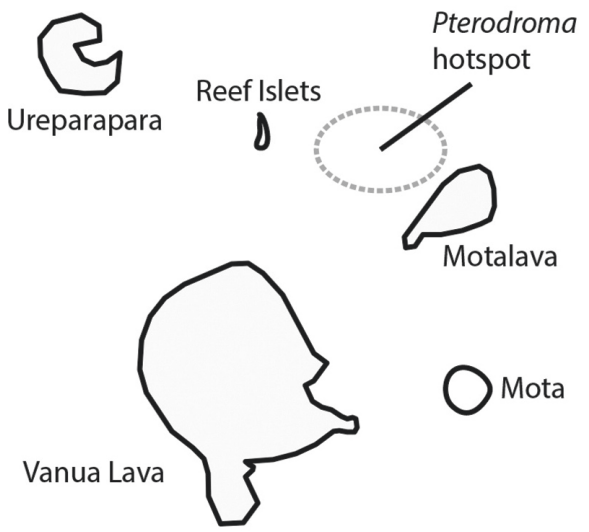

Figure 4. Map of the northern Banks Islands, North Vanuatu, marking the locations mentioned in the text, as well as the 'hotspot' for returning Magnificent Petrels (H. Shirihai *in litt*. 2017) and Vanuatu Petrels (Bretagnolle & Shirihai 2010).

Figure 5. Vanuatu Petrel *Pterodroma* (*cervicalis*) *occulta*, between the Reef Islands and Mota Lava, *c*.12 km north-east of Vanua Lava, 9 January 2017, with extensive white 'tongues' on the underside of the primaries, like extreme examples of White-necked Petrel *Pterodroma* (*c*.) *cervicalis* (Kirk Zufelt)

seabirds (frigatebirds *Fregata*, boobies *Sula*, noddies *Anous* and terns *Sterna*) that often attracted small numbers of Vanuatu Petrels. Groups of 2–6 *P.* (*c*.) *occulta* were found loafing at sea in the late afternoon and evening, north-east of Vanua Lava, between the Reef Islets and Mota Lava. Birds were observed landing, swimming toward each other, and preening. 8 January—six at sea while approaching Vanua Lava, five in the afternoon with feeding frenzies, then 20 at the 'hotspot' in the evening, with two or more calling occasionally 1 km offshore 22.00–23.00 h (the *toooooo-wit* call described by Totterman 2009: 60). 9 January—six in the afternoon with feeding frenzies, and ten at the 'hotspot' in the evening. 10 January—three in the afternoon with feeding frenzies, but none at the 'hotspot' before departure at dusk. 11 January—five at sea, mainly with feeding frenzies.

Identification of Vanuatu Petrel away from the Banks Islands necessitates correct judgement of size and the extent of white 'tongues' on the underside of the primaries beyond the greater primary-coverts (Shirihai & Bretagnolle 2010: 135). We found greater variation in the underwing pattern than Shirihai & Bretagnolle (2010). Their Fig. 6 (p. 137)

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shows a White-necked Petrel with extensive white 'tongues'. The legend states that such extensive white has yet to be found in Vanuatu Petrel and might reliably identify White-necked Petrel. On 9 January, we found two same-sized Vanuatu Petrels together on the sea between the Reef Islands and Mota Lava, *c*.12 km north-east of Vanua Lava. They eventually flew off. One had a fairly typical underwing pattern, with largely dark primaries, while the other had extensive white 'tongues', equivalent to the extreme for White-necked Petrel shown in Shirihai & Bretagnolle (2010: Fig. 6; compare our Fig. 5). At the other extreme, studies in the Kermadec Islands found that 9% of White-necked Petrels had a mainly dark underside to the primaries like typical Vanuatu Petrel (Shirihai & Bretagnolle 2010: 136 and Fig. 8). Consequently, pelagic identification of Vanuatu and White-necked Petrels away from their respective breeding islands will depend solely on correct judgement of size, which of course is difficult to establish at sea.

HEINROTH'S SHEARWATER *Puffinus heinrothi*

The locations of our sightings correspond with suspected breeding on Rendova and Kolombangara Islands, Solomon Islands, and on Bougainville Island, Papua New Guinea (Harrison 2014; Fig. 1). We observed five at sea: 17 January—one in Vella Gulf, between Kolombangara, Ghizo and Vella Lavella Islands; 18 January—two singles off the Shortland Islands, Solomons; 19 January—two singles *c*.65 km west of the north-west end of Bougainville Island. The rest of our sightings involved singles and small groups in the Blackett Strait, a narrow oceanic passage between the islands of Kolombangara and Kohinggo, Western Province, Solomons (Fig. 6). We found Heinroth's Shearwaters strongly associated with sizeable mixed feeding and rafting flocks of noddies and terns (as did Cheshire 2010 and Harrison 2014). Flocks went into frenzies over feeding tuna that pushed bait fish to the surface. Fish activity during our visit occurred mainly early to

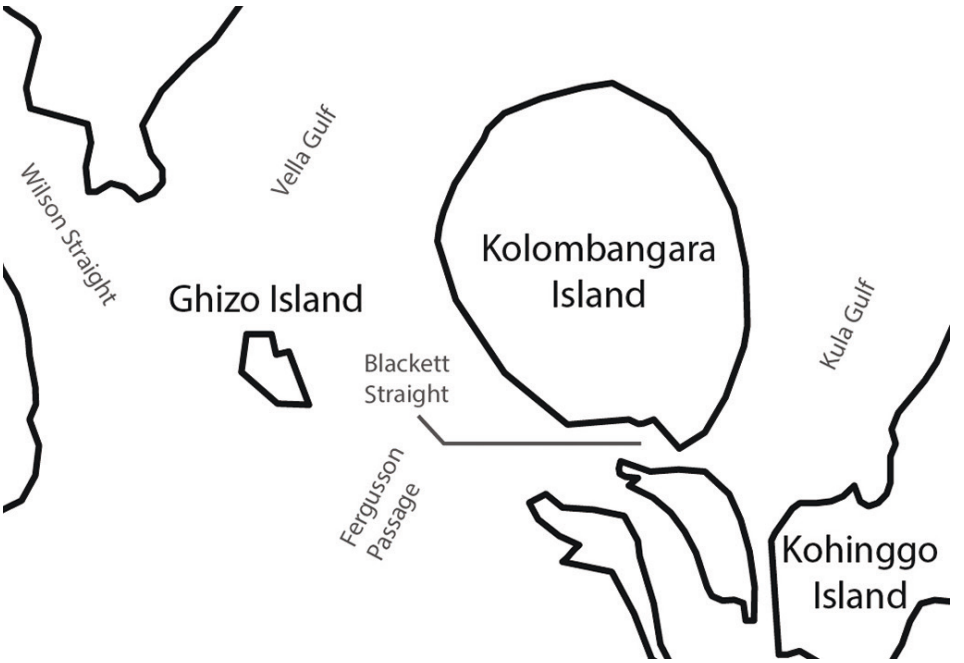

Figure 6. Map of the study area for Heinroth's Shearwater *Puffinus heinrothi* showing Blackett Strait, Vella Gulf and Fergusson Passage.

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Figure 7. Moulting Heinroth's Shearwater *Puffinus heinrothi*, Blackett Strait, between Kolombangara and Kohinggo Islands, Solomons, 29 January 2017; outer three primaries old and moult ongoing in middle primaries (Kirk Zufelt)

mid-morning, and mid-afternoon to late evening (Gibbs 1996 also noted evening activity off Kolombangara), but may have been influenced by tidal flows. We made the following sightings in Blackett Strait: 17 January—two at *c*.12.00 h as we motored en route to New Ireland; 25 January—having just returned from New Ireland, four in the evening; 26 January—at 07.30–09.30 h 6–8 birds, then 15.30–17.45 h 10–12, *c*.16 in total. 27 January—at 07.30–09.30 h 6–8 birds, not searched for in afternoon; 28 January—at 07.30–09.30 h 6–8 birds, then 15.30–17.30 h 8–10, *c*.14 in total; 29 January—at 07.30–10.30 h 16–18 birds, not searched for in afternoon; 30 January—at 07.30–11.30 h 6–8 birds, none in afternoon (also no noddies or terns); 31 January—at 07.30–11.30 h 6–8 birds, then disembarked *Sauvage*. There was some turnover in Blackett Strait. For example, on 26 January the majority were pale morph, whereas on 28 January approximately the same number of birds were seen but most were dark morph. Some, recognisable by a distinct marking, or by wear or moult in the primaries, were seen only once. We estimate a total of 30–50 in Blackett Strait.

On 20–25 March 2013, Harrison (2014) observed flocks of 1–25 birds, usually 50–60 per day in Vella Gulf adjoining Blackett Strait. On 21 September 2015, P. Sweet (*in litt*. 2017) saw 25 simultaneously in the adjoining Fergusson Passage. There were fewer birds present during our January expedition compared to the March and September visits.

Our photographs reveal a range of wear and moult in the flight feathers. Few birds had fresh plumage. Most showed light to moderate wear, the most worn feathers often being the central tail feathers, and the tail was heavily abraded in one individual. At least one bird showed moult contrast in a full set of secondaries. The only bird in active primary moult had old, worn and bleached pp8–10, with moult ongoing in the middle primaries (Fig. 7). Accordingly, the birds could have been a mix of immatures and adults, given a fixed breeding season (e.g. January / March–August / September); or largely / all adults, given a protracted season.

That said, the breeding season of Heinroth's Shearwater is barely known. No egg or nest has ever been found (Pikacha & Sirikolo 2010, Harrison 2014). Including our sightings, there are documented records offshore from suspected breeding islands in January, March, April, July, August and September (Hadden 1981, Gibbs 1996, Tarburton 2009, 2017, Harrison 2014; C. Collins *in litt*. 2017, P. Sweet *in litt*. 2017). Two records on Bougainville

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Figure 8. An immature White-bellied Sea Eagle *Haliaeetus leucogaster* attempting to predate a lone Heinroth's Shearwater *Puffinus heinrothi* on the sea, Blackett Strait, between Kolombangara and Kohinggo Islands, Solomons, 27 January 2017 (Kirk Zufelt)

are consistent with a regular breeding period (Hadden 1981: 23). A fledgling was found in August near the sea at Arawa, probably on its first flight. Nearby, inland at Panguna, an adult was found in July, probably en route to or from its nest. Significantly more birds in Vella Gulf in March 2013 (Harrison 2014), compared to Vella Gulf and Blackett Strait in January 2017, may mark the period of return to the breeding grounds (January–March). Thus breeding could occur January / March–August / September. Consistent with this is evidence of dispersal to Sulawesi, Indonesia, in October–March (at least). Sightings include flocks of 70+ off Taliabu (November 2012) and 209 north of Mangole, Sula Islands (March 2017) documented by photographs and video (Eaton *et al*. 2016; J. del Hoyo, J. Eaton, R. Hutchinson *in litt*. 2017).

Out of synch with the above timing, however, is the type specimen, a fledgling collected in New Britain on 27 May 1901 (Heinroth 1902). If our moulting bird was a juvenile in its second pre-basic moult, then it too may have fledged May / June. Fledglings in May / June and August would point to a protracted breeding season, with one or more egg-laying peaks.

The feeding behaviour that we observed was much as described by Shirihai (2004) and Harrison (2014). Finally, we witnessed an immature White-bellied Sea-eagle *Haliaeetus leucogaster* make a failed attempt to predate a lone Heinroth's Shearwater on the sea. The shearwater avoided capture by diving (Fig. 8). We were surprised to observe White-bellied Sea Eagle as Sanford's Sea-eagle *H. sanfordi* replaces it in the Solomons (identification substantiated in Wilson *et al*. in prep.).

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